By way of background, the present invention is based upon the surprising discovery that the addition of one or more bis-silyl aminosilanes to a vinyl silane solution not only significantly improves the storage stability of the solution, but also significantly improves the corrosion protection provided by the solution. Applicants had previously found that the corrosion of metal, such as galvanized steel, can be prevented by applying a treatment solution containing one ore more hydrolyzed vinyl silanes to the metal (see U.S. Patent No. 5,759,629). While this treatment method using a vinyl silane solution provides corrosion protection, the vinyl silane solutions of U.S. Patent No. 5,759,629 have limited storage stability. Quite surprisingly, Applicants have now found that the addition of even a small amount of one or more bis-silyl aminosilanes to a vinyl silane solution significantly improves the corrosion protection provided by that solution when applied to a zinc-containing metal surface or a metal surface having a zinc-containing coating. Furthermore, the addition of one or more bis-silyl aminosilanes also improves the storage stability of the solution.

As evidence of the surprising synergistic results, the Examiner directed to the examples found on pages 16-18 of the specification, wherein various silane solutions were tested under aggressive, corrosion-inducing conditions. As expected, untreated HDG panels exhibited significant corrosion, while those treated with a standard phosphate conversion coating and chromate rinse did not. More importantly, HDG panels treated with aqueous solutions containing only vinyltrimethoxysilane, methyltrimethoxysilane, 1,2-bis-(triethoxysilyl) ethane ("BTSE"), or bis-(trimethoxysilylpropyl) amine ("A-1170") had more than 10% of their surfaces covered with white rust after testing. Likewise, HDG panels treated with a mixture of BTSE and vinyltrimethoxysilane, or a mixture of BTSE and methyltrimethoxysilane also exhibited more than 10% rust coverage after testing.

In contrast, the addition of even a small amount of A-1170 to a vinyltrimethoxysilane solution provided astonishing improvements in corrosion protection. Specifically, as noted on page 18 of the specification, HDG panels treated with a solution containing 4.5% vinyltrimethoxysilane and 0.5% A-1170 exhibited white rust coverage of only 0.8% after a fourteen-day stack test, as compared to greater than 10% for HDG panels treated with a solution containing 5% vinyltrimethoxysilane alone. This greater than ten-fold increase in corrosion protection is quite astonishing considering that only a small portion of the vinyltrimethoxysilane was replaced with A-1170. Surprising results were also obtained at other ratios of vinyltrimethoxysilane to A-1170, as indicated in the specification. It also cannot be ignored that the addition of a bis-silyl aminosilane to a vinyl silane solution also improves storage stability of that solution.

Moreover, Applicants have also demonstrated that these surprising improvements in corrosion protection are further enhanced when the concentration of vinyl silanes is approximately equal to or greater than the concentration of aminosilanes in the treatment solution (see claim 15). Corrosion protection is even greater when ratio of vinyl silanes to aminosilanes is at least about 4. Thus, Applicants have added new claim 39 which specifies such a ratio, and this new claim is supported by the specification at, for example, page 12, lines 15-17. Although lower ratios provide unexpected improvements in storage stability, corrosion protection is greater at ratios of at least about 4.

As evidence of the significance of a vinyl silane to aminosilane ration of at least about 4, the Examiner's attention is directed to the Examples on page 17-18 of the specification. In particular, HDG panels treated with a silane solution having a 3:1 silane ratio exhibited 13.5% white rust coverage after a 14 day stack test, while panels treated with a silane solution having a 4:1 silane ratio exhibited only 6.3% white rust coverage. Thus, this slight modification in the silane ratio resulted in a greater than 50% decrease in rust coverage.

Turning to the patents cited by the Examiner, the Poutasse reference does indeed teach the use of an aqueous mixture of two silanes, and includes a long, laundry list of suitable silanes which include bis-silyl aminosilanes and vinyl silanes.

However, nowhere does Poutasse teach the specific combination of a bis-silyl aminosilane and a vinyl silane. In fact, none of the specific examples of Poutasse employ <u>any</u> bis-silyl silane, let alone a bis-silyl aminosilane. As the Examiner is aware, the broad teachings of a reference cannot preclude the establishment of unobviousness for a specifically claimed invention not anticipated by the reference. *In re Meyer*, 202 U.S.P.Q. 175 (CCPA 1979). The new and unexpected results demonstrated by applicants (as discussed above) clearly are sufficient to rebut the obviousness rejection based upon the Poutasse reference. For example, Applicants have demonstrated that the claimed mixtures of a bis-silyl aminosilane and a vinyl silane provides significant and unexpected improvements in corrosion protection as compared to either silane alone, or even mixtures of, for example, a vinyl silane and a bis-silyl silane not having an amino functionality (e.g. BTSE). Claims to a process involving a combination of components within the broad teaching of the prior art are patentable when the combination produces an unexpected result. *In re Sebek*, 175 U.S.P.Q. 93 (CCPA 1972). In addition, Applicants allegations of unexpected results must be considered even if the claimed process is within the broad teachings of the prior art. *In re Costello*, 178 U.S.P.Q. 290 (CCPA 1973). Because of the unexpected

results demonstrated by Applicants for the claimed invention, the rejection based upon the Poutasse reference is believed to be overcome.

Furthermore, with respect to claims 15 and 39, nowhere does Poutasse suggest that there is any significance in the ratio of the two silanes employed. For example, the preferred ratio of the two silanes in Poutasse is from about 10:90 to about 90:10 (see col. 8, lines 5-7). In addition, the only example in Poutasse wherein various silane ratios were tested demonstrated no significant difference in the performance of a variety of silane ratios (see Example 5 of Poutasse, col. 11, lines 15-45). Thus, the specific silane ratios of claims 15 and 39 are clearly patentable over Poutasse, especially given the unexpected results demonstrated by Applicants.

The Brown patent cited by the Examiner is similar to Poutasse in that it teaches the application of a mixture of silanes to a metal substrate, particularly a mixture of a vinyl silane and a "multi-silyl-functional silane." Although bis-silyl aminosilanes are included in the list of suitable multi-silyl-functional silanes, the Brown reference does not specifically teach Applicants' claimed mixture. In fact, Brown states that the preferred multi-functional silane is 1,2-bis (triethoxysilyl) ethane - i.e. BTSE (col. 5, lines 40-42). However, Applicants have demonstrated that the mixture of a vinyl silane and a bis-silyl aminosilane provides surprisingly superior corrosion protection as compared to a mixture of this same vinyl silane and BTSE. Therefore, these unexpected results are believed to be sufficient to overcome the obviousness rejection based upon the Brown reference.

Like Poutasse, Brown also fails to teach or suggest the silane ratios of claims 15 and 39. In fact, the teachings of Brown are directly contrary to the silane ratios of claims 15 and 29 of the present application. Specifically, Brown states that the preferred ratio of vinyl silanes to multi-silyl-functional silanes is 1:2. In contrast, Applicants have shown that, for mixtures of a vinyl silane and a bis-silyl aminosilane, the ratio is preferably at least about 1 (claim 15), more preferably at least about 4 (claim 39). This distinction further supports the conclusion that all of the claims of the present application, and in particular claims 15 and 39, are patentable over Brown.

Finally, the Bishop reference cited by the Examiner suffers from the same deficiencies as the Poutasse and Brown references. Bishop is directed to acidic solutions which contain a silane chosen from a long list of suitable silanes (including vinyl silanes). Bishop also states that the solution may optionally include a second silane chosen from a group of silanes which includes bis-silyl aminosilanes. However, nowhere does Bishop teach or suggest the specific combination claimed by Applicants. In fact, the closest example provided in Bishop is Example 4 (col. 6, lines 16-20), which only contains vinyltrimethoxysilane. However, as discussed above, Applicants have

demonstrated the unexpected superiority of their claimed mixture as compared to solutions containing only a vinyl silane, as well as the other silane solutions taught by Bishop. With respect to claims 15 and 39, nowhere does Bishop provide any indication of preferred silane ratios. Therefore, given Applicants demonstration of these preferred silane ratios, claims 15 and 39 cannot be considered obvious over Bishop.

For the foregoing reasons, Applicants believe that all of the claims are allowable over the references cited by the Examiner.

Respectfully submitted,

By _____

Martin J. Miller
Registration No. 35,953
Attorney for Applicant(s)
DINSMORE & SHOHL LLP
1900 Chemed Center
255 East Fifth Street
Cincinnati, OH 45202
(513) 977-8565

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